TABLE 5.—*Comparison of mean and extreme rainfalls at the Abbe Observatory (O.) and at the Government building (G.), April, 1915–March, 1917.*

Month.	Mean totals.		Difference.	Greatest in 24 hours.		Greatest differences.					
						For the hour.			For the day.		
						Amounts.		Difference.	Amounts.		Difference.
	O.	G.		O.	G.	O.	G.		O.	G.	
	Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
April	1.68	1.52	0.16	0.77	0.57	0.55	0.37	0.18	0.73	0.49	0.24
May	5.02	4.81	0.21	2.34	1.75	0.83	0.44	0.39	2.29	1.71	0.58
June	4.40	4.18	0.22	1.37	1.59	0.24	0.77	0.53	1.06	0.41	0.65
July	3.36	3.04	0.32	1.44	1.36	0.43	0.00	0.43	1.43	0.35	1.08
August	3.85	3.84	0.01	1.70	1.34	0.25	0.61	0.36	1.01	0.53	0.48
September	4.47	3.55	0.08	2.32	2.04	0.78	0.47	0.31	1.36	0.89	0.47
October	2.08	1.89	0.19	1.32	1.10	0.09	0.32	0.23	1.32	0.90	0.42
November	2.10	1.94	0.16	1.27	1.09	0.25	0.19	0.06	1.23	1.02	0.21
December	4.10	4.02	0.08	2.10	2.03	0.12	T.	0.12	1.28	1.49	0.21
January	5.29	5.42	0.13	1.72	1.82	0.40	0.24	0.16	0.11	0.29	0.18
February	1.62	1.82	0.20	1.13	1.29	0.11	0.42	0.31	0.76	1.18	0.42
March	3.70	3.68	0.02	1.19	1.38	0.22	0.77	0.55	0.98	1.38	0.40
Year	41.67	39.71	1.96	2.34	2.04	0.22	0.77	0.55	1.43	0.35	1.08

The greatest amount of precipitation in 24 hours did not vary greatly at the two places, the greatest difference being 0.59 inch during May, 1916. During this month and also during several other months the greatest amount in 24 hours did not occur on the same day at the two places. A greater difference is shown when the same days are considered at each station. On July 28, 1915, the precipitation at the observatory was 1.43 inches and only 0.35 inch at the Government building, making a difference of 1.08 inches. On July 28 there was a rainfall of 0.48 inch at the observatory of which 0.43 inch fell in one hour, while none occurred at the Government building. The greatest difference for any hour during the two years occurred in March, 1917, when 0.22 inch fell at the observatory and 0.77 inch was measured at the Government building. The greatest amounts of precipitation for 5, 10, 15, and 30 minutes and for one and two hours during each month did not, as a rule, differ much at the two locations, but in several months the maximum amounts for those periods did not occur on the same day at the two places.

It will require several years of comparative records to determine accurately the percentage difference between the precipitation measurements at the Abbe Observatory and at the Government building, due to the difference in exposure of the raingages.

CLOUDINESS AND FOG.

The number of clear, partly cloudy, and cloudy days during the year at the two places were the same. There was more cloudiness and light fog during the early morning hours at the Government building than at the observatory, but this was due, at least in part, to the extra amount of local smoke that collected in the valley on mornings when the wind was very light. As soon as the velocity of the wind increased the smoke was mostly blown out of the valley. Under low atmospheric pressure, even with moderate wind velocity, the clouds were more dense at the Government building than at the observatory, as the local smoke tended to settle toward the ground instead of rising high in the atmosphere. On two occasions there were dense fogs on the hilltops and very little fog in the valley. On these occasions the pressure was moderately high, and the fogs on the hilltops were caused by the passing of low clouds which did not settle in the valley.

WINTER INDOOR ARIDITY IN TOPEKA, KANS.[1]

628.8

By S. D. FLORA, Meteorologist.

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It is somewhat of a surprise to find that in the winter season a majority of persons in the northern part of the United States live in an indoor climate that is ultra-desert in regard to moisture conditions. A few years ago the writer was greatly interested in an account of the investigation of indoor aridity by Prof. R. DeC. Ward in Cambridge, Mass. (MONTHLY WEATHER REVIEW, September, 1908, **36**:281–283), and determined—in the apparent absence of corresponding data for a western State where conditions were probably more acute on account of the atmosphere being drier—to make a series of humidity observations, both indoors and out, that should cover an entire winter. The program was interfered with by other duties, but it was carried far enough to indicate that indoor climate in Kansas was drier under ordinary circumstances than in Massachusetts, and in severely cold weather was even drier than the desert region of the Southwest.

TABLE 1.—*Relative humidity indoors and outdoors at Topeka, Kans., November and December, 1909.*

Date.	Temperature of office room.		Relative humidity.		Temperature outdoors.	State of weather.
	Dry-bulb.	Wet-bulb.	Indoors.	Outdoors.		
1909.	°F.	°F.	%	%	°F.	
Nov. 18, 8 a. m.	71	55	33	77	27	Clear.
noon	72	53	25	49	43	Partly cloudy.
4 p. m.	72	54	28	47	53	Do.
19, 8 a. m.	71	53	29	76	38	Clear.
noon	72	54	30	46	54	Do.
4 p. m.	72	54	30	38	62	Partly cloudy.
20, 8 a. m.	72	58	40	93	47	Partly cloudy.
noon	71	57	39	60	59	Do.
4 p. m.	72	58	40	50	67	Do.
22, 8 a. m.	64	50	34	90	32	Cloudy.
noon	71	54	31	84	31	Do.
4 p. m.	72	57	39	70	37	Do.
23, 8 a. m.	75	55	25	85	23	Cloudy.
noon	73	55	28	70	40	Partly cloudy.
4 p. m.	72	54	30	56	48	Clear.
24, 8 a. m.	76	57	29	78	44	Clear.
noon	76	57	28	48	59	Do.
4 p. m.	76	59	32	46	65	Do.
25, noon	66	55	49	95	52	Cloudy.
26, 8 a. m.	66	56	53	83	58	Cloudy.
noon	74	62	52	79	66	Do.
4 p. m.	73	63	60	73	68	Partly cloudy.
27, 8 a. m.	73	62	53	81	61	Cloudy.
noon	72	61	52	79	64	Do.
4 p. m.	74	64	56	79	65	Do.
28, noon	69	55	38	92	38	Cloudy.
29, 8 a. m.	78	60	32	100	41	Foggy.
noon	70	66	39	99	44	Cloudy.
4 p. m.	72	58	40	97	46	Do.
30, 8 a. m.	82	62	31	100	46	Foggy.
noon	73	59	44	100	50	Cloudy.
4 p. m.	72	60	48	91	52	Do.
Dec. 1, 8 a. m.	74	60	44	100	49	Raining.
noon	76	59	35	69	52	Partly cloudy.
4 p. m.	74	58	37	74	50	Cloudy.
2, 8 a. m.	70	55	37	84	42	Cloudy.
noon	70	54	32	73	43	Do.
4 p. m.	73	56	33	67	45	Do.
3, 8 a. m.	67	53	36	80	41	Sprinkling.
noon	69	54	37	95	41	Do.
4 p. m.	74	58	37	99	41	Raining.
4, 8 a. m.	69	53	31	94	26	Sleeting.
noon	72	52	22	100	23	Cloudy.
4 p. m.	71	52	25	89	22	Do.

[1] A summary of the results of these measurements was published in Bulletin, Kansas State Board of Health, Topeka, January, 1917, 13: 9–11. 8°.

TABLE 1.—*Relative humidity indoors and outdoors at Topeka, Kans., November and December, 1909*—Continued.

Date.	Temperature of office room.		Relative humidity.		Temperature outdoors.	State of weather.
	Dry-bulb.	Wet-bulb	Indoors.	Outdoors.		
1909.	°F.	°F.	%	%	°F.	
Dec. 13, 8 a. m.	79	57	21	91	23	Cloudy.
noon	73	53	23	82	24	Snowing.
4 p. m.	75	55	23	88	29	Cloudy.
14, 8 a. m.	78	57	25	94	25	Cloudy.
noon	74	54	24	67	29	Partly cloudy.
4 p. m.	76	54	20	64	28	Clear.
15, 8 a. m.	78	55	19	97	17	Clear.
noon	72	52	22	68	26	Do.
4 p. m.	76	54	20	64	32	Do.
16, 8 a. m.	75	54	21	87	30	Cloudy.
noon	73	54	25	72	37	Do.
4 p. m.	74	53	21	63	36	Do.
17, 8 a. m.	68	50	23	80	7	Partly cloudy.
noon	70	50	19	61	11	Clear.
4 p. m.	74	52	18	47	13	Do.
18, 8 a. m.	75	51	15	80	6	Clear.
noon	73	52	19	80	12	Partly cloudy.
4 p. m.	73	51	17	65	18	Clear.
20, 8 a. m.	69	49	17	75	6	Clear.
noon	73	52	20	73	16	Do.
4 p. m.	73	53	23	72	22	Do.
21, 8 a. m.	71	50	18	79	11	Partly cloudy.
noon	73	51	18	69	19	Clear.
4 p. m.	73	53	22	75	26	Do.
22, 8 a. m.	69	49	20	96	14	Cloudy.
noon	73	52	20	92	18	Snowing.
4 p. m.	76	54	20	88	20	Do.
23, 8 a. m.	77	54	18	100	17	Cloudy.
noon	72	52	20	88	24	Do.
4 p. m.	76	54	20	79	31	Do.
24, noon	80	58	24	100	32	Cloudy.
27, 8 a. m.	77	55	21	84	17	Clear.
noon	74	52	16	65	26	Do.
4 p. m.	74	56	32	69	31	Do.
28, 8 a. m.	77	55	21	90	25	Cloudy.
noon	76	54	19	85	20	Partly cloudy.
4 p. m.	77	53	15	68	18	Clear.
29, 8 a. m.	74	51	15	93	−1	Clear.
noon	73	51	15	69	5	Do.
4 p. m.	76	52	14	54	8	Do.
30, 8 a. m.	74	51	15	72	19	Partly cloudy.
noon	74	52	18	69	33	Clear.
4 p. m.	73	53	23	62	37	Do.
31, 8 a. m.	77	55	21	87	28	Cloudy.
noon	75	54	22	69	39	Do.
Means, 8 a. m.	73.3	54.6	27.5	87.1	28.2	
noon	72.6	54.5	28.4	76.5	35.3	
4 p. m.	73.8	55.6	29.4	69.1	38.2	
Means of all observations	73.2	54.8	28.4	77.6	33.9	
Means of December observations	74	54	23	79	25	

TABLE 2.—*Humidity of arid regions and indoor winter climate.*

Stations.	Average annual relative humidity.	Average relative humidity during driest month of year, and month.
	%	
Yuma, Ariz.	43	35 per cent in June.
Santa Fe, N. Mex.	45	29 per cent in June.
Pueblo, Colo.	46	38 per cent in April.

Death Valley, Cal., from May to September, 1891	23%
Indoors at Cambridge, Mass., November, 1899	30
Indoors at Topeka, Kans., November and December, 1890	28
Indoors at Topeka, Kans., December, 1909	23

It is apparent from a study of Table 1 that the chief cause of indoor aridity is the difference in temperature between the air indoors and out. This was specially noticeable on December 29, 1909, when the lowest relative humidity indoors and the lowest temperature outdoors occurred. However, the outdoor humidity, specially the absolute humidity there, is also an important factor. The latter point is brought out more clearly by the means of the 8 a. m., noon, and 4 p. m. observations, which show that, while the relative humidity outdoors decreased during the day, indoors it increased. This was undoubtedly due to the fact that, as shown by computation, the absolute humidity increased from 1.54 grains per cubic foot at 8 a. m. to 1.81 grains at noon and 1.82 grains at 4 p. m. In other words, the more moisture in the air admitted to the room from outside the less the tendency to aridity after it was warmed up.

The indoor observations recorded in the tables were made with the Weather Bureau sling psychrometer in the front room of the suite occupied by the Weather Bureau (997 feet above sealevel), a room 14 by 18 feet, with a 10-foot ceiling, steam heated, with no provision for adding moisture to the air, and no arrangement for ventilation except through the windows. In general it is a well-lighted room and fairly well ventilated, and is in most respects typical of the ordinary office room. The outdoor observations were made 85 feet above the ground, in the instrument shelter on the roof, with the ordinary type of whirling psychrometer.

During the period covered by the observations the sling psychrometer was used to ascertain the relative humidity of living rooms in various parts of Topeka from time to time, and it was demonstrated that conditions in such rooms did not differ materially from those in the office room.

Specialists on throat diseases are agreed that air as dry as that found indoors in these observations is liable to set up an irritation in the delicate mucous lining of the air passages of the throat, which is at least an indirect cause of a great deal of catarrh, bad colds, and even tuberculosis, that are all too common in cold climates in the winter season.

Raising the humidity of a room by the familiar device of setting a pan of water on a stove or radiator is not nearly as easy as is commonly supposed. To raise the relative humidity of a room 14 by 18 feet, with a 10-foot ceiling, from 23 per cent to 79 per cent and maintain its temperature at 74°, requires the addition of the vapor from a little more than a quart of water. To raise its humidity even to 50 per cent would require the moisture from approximately $1\frac{1}{6}$ pints of water.

Increasing the humidity of the air already in a room is, however, only the beginning of the trouble. The air must be renewed from time to time for ventilation. Good ventilation is said to require the addition of at least 25 cubic feet of fresh air per minute for each person in the room (Chambers' Encyclopedia under "Ventilation"). Under outside conditions similar to those shown in the December series of observations, to maintain a room at a temperature of 74° and a relative humidity of 50 per cent, and ventilate it properly for 4 persons for 16 hours of a day, would require the evaporation of almost 3 pints of water every hour, or $5\frac{1}{2}$ gallons for the 16-hour day. To ventilate properly a school room with 40 pupils in it and maintain its temperature at 74° and its relative humidity at 50 per cent under similar weather conditions would necessitate the evaporation of almost a barrel of water each 8 hours, which would certainly be considered impracticable with present-day heating apparatus.

However, by keeping the temperature of the room at 65° instead of 74°, the amount of water vapor necessary to maintain the desired relative humidity of 50 per cent would be reduced almost half.

It is somewhat of a question whether it is desirable to maintain a relative humidity as high as 50 per cent in cold weather. Air at a temperature of 74° and a relative humidity of 40 per cent will become saturated when its temperature is reduced to about 48°, and it is not uncommon for the surface of window panes and walls of a room to become that cold when the outside temperature is as low as 0°F. In fact it was noted in making humidity observations in residences that, when the indoor humidity was as high as 50 per cent in cold weather, the windows and even painted walls of rooms were usually dripping with moisture. To pass from a stay in a room this damp into a piercing winter wind is something not many persons care to make a practice of.

The most obvious solution of the problem in the light of the foregoing would seem to be to keep living rooms from being excessively heated, since the difference of a few degrees makes a marked difference in the relative humidity, and to arrange that a reasonable quantity of water be evaporated in the room daily. It would hardly seem to be necessary to state that aridity in sleeping rooms may be entirely avoided by good ventilation and the absence of artificial heat.

551.577 (684.3)

THE PREPARATION OF PRECIPITATION CHARTS.

By WM. GARDNER REED and JOSEPH BURTON KINCER.

[Dated: Climatological Division, June 30, 1917.]

When the preparation of the Atlas of American Agriculture was undertaken by the United States Department of Agriculture, the importance of climate in its relation to agriculture was recognized and a section of the Atlas was very properly devoted to climate. This opportunity was taken to construct a new series of climatic charts with the aid of the data which have been accumulated since the existing maps were drawn. Particularly in the case of precipitation there was an opportunity to construct maps which should depict the conditions more accurately than had heretofore been possible. It seemed proper to review the principles upon which precipitation maps should be drawn and determine how far the data available would permit the construction of maps nearly approaching the ideal. Other climatological maps are now in preparation by the Weather Bureau, and the map of the annual precipitation over the United States was issued in "January, 1917," as "Advance Sheet No. 1: Precipitation" of the Atlas mentioned above.

There is probably no climatic factor concerning which so much has been written as precipitation. From the discussions of the subject it has been possible to formulate a set of rules for the construction of maps which present its distribution graphically.[1]

1. Gage records, except such as have been shown to be in error, e. g., by comparison with neighboring records, should be regarded as the "control" of the map. In spite of the doubts as to whether gage readings agree with the actual precipitation there can be no doubt that these records are the only comparable numerical precipitation data in existence.

2. The data should refer to the same period, which should be as long as possible. This is desirable because of the differences in amount from year to year, and, to be comparable, records must cover the same years. The period selected should be one for which a very considerable number of records are available, because only by the use of many records can the geographical distribution adequately be shown.

3. When these data have been entered on a map there will appear many areas where the course of isohyets drawn to the data will remain in doubt. As there is no convenient artifice for representing "no data," and because the best approximations to the actual conditions in such regions can be made by meteorologists familiar with the data, it seems desirable that the maps should show the probable conditions where records are not sufficient to permit the portrayal of the actual conditions.

To fill these gaps, interpolations are necessary but, unless they be made wisely, the resulting map will not be a true picture of the conditions as they exist. The data upon which interpolations may be made vary greatly, not only in adequacy but in kind. The most useful data for interpolation are gage records covering a portion of the selected period. The precipitation for the whole period may then be deduced from these incomplete records by a comparison with neighboring complete records. Another kind of interpolation is based on analogy; for example, if the precipitation conditions on one mountain range have been determined by adequate gage readings, the same conditions may be inferred on a near-by range of the same elevation and similar exposure, covered with the same or closely allied vegetation and yielding a similar stream flow. Likewise, in the absence of more accurate information, precipitation conditions may be inferred as similar in neighboring valleys of the same mountain group if the elevation of these valleys and their vegetation are similar. Again, differences in vegetation and in the known laws of change in amount of precipitation with altitude, latitude, or distance from the ocean may be of assistance in indicating that a region is wetter or drier than a near-by region in which measurements are available.

In the preparation of a map which shall adequately represent the precipitation of a region, such as the United States, the following should be kept in mind:

1. On account of the great diversity of topography the map must be more or less generalized with the attendant sacrifice of accuracy of detail. In fact, it is probably better to regard any map as a general illustration and to refer to the actual data for detailed information.

2. The "control" of the map should be gage records, covering the same period of years.

3. If complete gage records for the period selected (which should be not less than 20 years) do not exist in sufficient number, the shorter records within the same period should be reduced to the complete period.

4. It must be remembered that in drawing an isohyet from one station to another interpolation is of necessity involved at all points between the stations. Therefore it is well to draw these lines having in mind the topography, the stream flow, and the natural and cultivated vegetation, and to give weight to these conditions in carrying the isohyets from station to station.

5. The object of a precipitation map is to show graphically the distribution of rainfall over the area for which the map is drawn. A map which does not accomplish this is not a good map, and saving clauses such as statements that the precipitation is greater or less than a certain amount should be avoided as far as possible. For example, it is literally correct to mark a region "10 inches plus," where the fall may be 40 inches, but such a practice may be greatly misleading under some condi-

[1] For a collection of expert opinions on the construction of rainfall maps see the MONTHLY WEATHER REVIEW, April, 1902, 30: 205-243, and 2 charts.—EDITOR.